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SKID RESPONSIVE SYSTEM FOR DISENGAGING A VEHICLE CLUTCH

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(54) SKID RESPONSIVE SYSTEM FOR DISENGAGING A VEHICLE CLUTCH

(71) We, KELSEY-HAYES COMPANY, a Corporation organised and existing under the laws of the State of Delaware, United States of America, of 38481 Huron River Drive, Romulus, Michigan, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a clutch disengaging system for use with a wheeled vehicle having a manually operated transmission and to a vehicle embodying such a system.

When a wheeled vehicle equipped with a manually operated transmission is driven towards a skid candition, e.g. during a panic stop, the engine is subject to stall by failure of the driver promptly to disengage the clutch. A stalled engine results in the loss of various engine powered accessories, such as power steering and brakes, which are dependent on pressurized hydraulic fluid provided by auxiliary pumps and boosters driven by the engine. At the same time engine stalling can result in loss of engine vecuum which may serve as a power source for other accessories such as a skid control modulating valve. Moreover, when the engine stalls, the static engine load is placed on the drive line and drive wheels which could provide a serious obstacle to a skid control system in controlling the wheels during controlled braking.

With some skid control systems, upon the occurrence of an incipient skid condition the brakes are cyclically relieved and reapplied so as to avoid a locked wheel condition. When the brakes are relieved, the wheels are allowed to spin-up. If, however, the static engine load is placed on the drive line and drive wheels during a skid control cycle, the imposed load may retard the spin-up of the wheels which may result in the occurrence of a locked wheel condition despite the efforts of the skid control system.

According to the present invention there is provided a system for automatically disengaging the clutch of a wheeled vehicle having fluid pressure actuated brakes and a manually operable transmission and clutch during the imminence of a wheel skid condition, the system comprising sensing means for detecting the imminence of wheel skid conditions and providing output signals in response thereto; and actuating means responsive to at least one of the output signals for disengaging the clutch, and cancelling means, including timing means for establishing a predetermined time interval following operation of the actuating means, for permitting the clutch to be reengaged after elapse of the time interval.

Preferably the actuating means includes latching means for maintaining the actuating means actuated for a time duration greater than that of each of the output signals, the timing means being arranged to restart the predetermined time interval upon a subsequent output signal whereby the actuatng means can maintain the clutch disengaged over a plurality of the output signals.

The present invention will become further apparent from the subsequent exemplary description taken in conjunction with the acompanying drawings, in which:—

Figure 1 is a combined schematic and block diagram of a skid control system embodying the present invention;

Figure 2 is an exemplary wiring diagram of the latching circuit illustrated in Figure 1; and

Figure 3 is a graphical represntation of brake pressure versus time for a skid control cycle and further indicating the relationship thereto of the skid control signal and the latch signal to the latching circuit.

A skid control system will be described specifically for use with an automotive vehicle having a manual transmission and a clutch arrangement normally operable by a foot pedal. As will be seen, the clutch is also adapted to be automatically activated in accordance with selective actuation of a solenoid valve. The skid control system can be of a type similar to that disclosed in the

specification of United States Patent No. 3,515,440. As indicated therein, the skid control system can be utilized in connection either with the front wheels, the rear wheels, or the front and rear wheels. For purposes of simplicity, the system will be described for use in conjunction with the rear wheels only of an automotive vehicle.

With reference now to Figure 1 of the drawings, the schematic diagram generally shows a skid control system for use with the rear wheels of an automotive vehicle, the rear wheels being equipped with brake drums 10 and wheel brake cylinders 12. Hydraulic lines 14 are connected to the cylinders 12 and to a common fluid line 16 which is pressurized by a master cylinder assembly 20 *via* a hydraulic line 18. The master cylinder assembly 20 can be of any conventional construction and actuated through a pedal 22. Fluid pressure from master cylinder 20 can be modulated by means of a skid control modulating valve 24 which is connected between the fluid lines 18 and 16. Moreover, the modulating valve 24 can control the fluid pressure to the wheel brake cylinders 12 and hence can control the operation of the brakes. The brakes associated with the brake drum 10 can be of a conventional construction and hence the details thereof have been omitted for purposes of simplicity. The modulating valve 24 can be of the type disclosed in the above mentioned United States patent specification which is dependent on a vacuum source.

The modulating valve 24 in the present system is actuated in accordance with an electrical signal obtained from an electrical control module 26. The control module 26 receives information from sensors 28 associated with each of the brake drums 10 by means of exciter rings 30. The exciter rings 30 and sensors 28 can be of constructions known in the art such that as the exciter rings 30 are rotated with the brake drums 10 (and hence with the associated wheels), the sensors 28 would provide a pulsating or alternating electrical signal *via* conductors 34 to the module 26, which signal would be an indication of the rotational velocity of the associated wheels.

The control module 26 can be constructed to sense the rate of change in the signal at the conductors 34 and hence to sense the deceleration rate of the wheels associated with the brake drums 10 and to provide an output signal in response to the magnitude of the deceleration of the wheels associated with the brake drums 10 reaching a preselected magnitude corresponding to a skid condition existing or to be occurring at the wheels associated with the drums 10. The output or control signal will be transmitted by means of conductor 32 to the modulating valve 24. In the system of the above mentioned patent specification the control module 26 was adapted to provide merely an "on" or "off" signal and modulation of the fluid pressure to the brake cylinders 12 will be provided by the modulating valve 24 in response to the control signal. Moreover, the control module 26 includes a command function which is adapted to disengage a clutch assembly 36 of a vehicle equipped with a manually operated transmission 38.

The clutch assembly 36 is interposed between an engine 40 and manual transmission 38, and includes a linkage 42 which is adapted for movement by the vehicle operator, as by depressing a pedal (not shown), selectively to engage and disengage the clutch assembly 36. A second linkage 44 is connected between the linkage 42 and a de-clutching mechanism 46, which may be a vacuum induced or hydraulic actuator adapted to disengage the clutch assembly 36 on energization of an electrically operated valve solenoid 48. The solenoid 48 could be energized *via* a suitable conductor (not shown) connecting the conductor 32, but the clutch assembly would then be cyclically engaged and disengaged in accordance with pressurizing and depressurizing the brake pressure.

To avoid unnecessary clutching and de-clutching during a plurality of signals emanating from the control module 26 for cyclically operating the modulating valve 24, a latching circuit 50 is provided. The latching circuit is connected to the control module 26 by a conductor 52, and to the solenoid 48 *via* a conductor 54. The latching circuit 50 may include an SCR, a relay, or other similar electrical component having a holding function and be adapted to be rendered conductive from an output signal from the control module 26, in a preferred form circuit 50 includes an SCR.

As best observed in Figure 2, the anode of the SCR is connected to a source of electrical energy, such as the positive terminal of a battery 56, by a conductor 58. The solenoid 48 has one end connected to the cathode of the SCR *via* the conductor 54 and has its opposite end connected to ground. The gate of the SCR is connected to an output circuit of the module 26. A timing circuit 60 is operatively interposed in the conductor 58 and adapted to open and close a connection to the latching circuit 50 from the battery 56. The timing circuit 60 is energized and started by the output signal from the control module 26 *via* a conductor 55 interposed between the circuit 60 and the conductor 52.

In operation, the SCR is placed in a condition to conduct when the connection through circuit 60 is closed; the SCR will be triggered into conduction then by an output signal from the control module 26 *via* the

conductor 52. When a wheel skid condition is occurring or imminent, however, the SCR will be triggered by a signal from the control module 26 rendering the SCR conductive, and actuating the solenoid 48 whereby the vehicle will be de-clutched by the mechanism 46. The timing circuit 60 will be simultaneously energized to commence timing. Once the SCR is rendered conductive it will remain in this state even though the signal at conductor 52 has terminated, until the circuit is opened by the timing circuit 60. Thus, it will be noted that the latching circuit 50 is not dependent on subsequent output signals from the module 26 adapted to cycle the valve 24, but only the initial signal therefrom. This sequence will hereinafter be further explained in conjunction with the description of Figure 3.

To provide a visual indication of failure or inoperativeness of the latching circuit 50, a comparator element 62 is provided which includes a first terminal 64 connected to the latching circuit 50 *via* a conductor 66 and a second terminal 68 connected to the electrical conductor 52 *via* a conductor 70. A light bulb 72, suitably located on the dashboard or other convenient location within the vehicle is connected to the comparator 62 by means of an electrical cnoductor 74, the light bulb being suitably grounded *via* a conductor 76. In the event the latching circuit 50 should fail to conduct and thereby not energize the solenoid 48 upon the occurrence of an output signal from the control module 26, lighting of the bulb 72 will indicate and warn the driver of the inoperativeness of the latching circuit 50 and hence of the inoperativeness of the de-clutching circuit.

With reference now to Figure 3 of the drawings, the brake pressure, the control module, output signal, and the de-clutching signal from the latching element 40 are graphically represented versus time. Curve "A" depicts the relationship of brake fluid pressure for a conventional braking system wherein the brakes are initially applied at time zero t_0 and illustrates the resulting increase of brake fluid pressure to the maximum fluid pressure available in the system. Under certain road conditions application of maximum brake pressure (or less) will result in excessive slip and a locked wheel and/or a skid condition. If the vehicle wheels are locked or slipping excessively, the effectiveness of the braking system in controllably stopping the vehicle is reduced. The brake pressure curve for braking the vehicle at a desired slip and hence utilizing the maximum coefficient of friction is shown as curve "B". It is a function of the skid control system to provide operational characteristics which will simulate the ideal brake pressure curve "B". Depending upon the surface conditions of the road, the ideal curve "B" will vary; and hence a family of ideal pressure curves could be constructed for various and different road conditions. For purposes of simplicity only one such curve has been shown.

In the system of the present invention, the modulating valve 24 in response to output signals from the module 26 will provide for a modulated brake pressure curve "C". The curve "C" preferably approximating the ideal brake pressure curve "B" and depending substantially on the inherent characteristics built into the modulating valve 24. The curve illustrates the output signal from the control module 26 and shows a time relation between output control signals "y" and the pressure curve "C". Correspondingly, the curve "Z" depicts the de-clutching signal to the solenoid 48 and shows the time relation between the output signals y, y_1 and y_2 and the pressure curve "C".

Presuming now that the brakes are applied at time t_0, the brake pressure will be increased along the curve "A" until a skid condition occurs at time t_1, at the point "d". This condition will be sensed and control module 26 will transmit an output signal "y" to actuate the modulating valve 24 and concurrently the latching circuit 50 by a signal from the module *via* the conductor 52. Energization of the modulating valve 24 results in relieving the brake fluid pressure to the wheel cylinders 12 towards point "e", while at the same time, the latching circuit 50 is now rendered conductive as indicated by z_1, on the curve "Z" which energizes the solenoid 48. As previously indicated, energization of the solenoid 48 actuates the de-clutching mechanism 46 whereby the vehicle engine 40 is drivingly disengaged from the transmission 38. At a point along the curve "d" to "e", the wheel of the vehicle will have spun-up or regained speed whereby the output signal "y" from the module 26 is terminated, as at time t_2, whereby the initial actuation of the modulating valve 24 is discontinued. When this occurs the modulating valve 24 is operative to return the fluid pressure quickly to a point "*f*" which is proximate to the ideal curve "B" and then to provide for a gradual increase of the fluid pressure along a gradually inclined curve from point "*f*" to point "*g*", generally approximating the shape of the curve "B". Note that during the fluctuation in fluid brake pressure from "*d*" to "*e*" and then to "*g*", the latching circuit 50 will continue to conduct, thereby retaining the engine 40 in a de-clutched condition relative to the manually operated tranmission 38. Upon reaching the point "*g*", the sensor element will again detect a skid condition whereby the previously discussed cycle "*d*" to "*g*" will be substantially repeated during the time interval

t_3 to t_5. Subsequent cycles will be continued until the wheel skid condition is remedied or conversely until the brake pedal is released by the vehicle operator as at time "t_7". At such time the timing circuit 60 will be operative to release the latching circuit 50, and the vehicle will be substantially restored to manual operation by the driver. The time interval (ΔT) between respective output pulses t_1 to t_3 or t_3 to t_5 from the control module 26 can be determined based upon the physical characteristics of the system. With the knowledge of at least an average interval between the frequency of the cyclic output signals y to y_1, etc., the timing circuit is set to cancel the operation of latching circuit 50 at an interval slightly exceeding the interval t_1 to t_3. It will be appreciated, however, that each time a new signal "y_1" relative to a prior signal "y" is generated from the control module 26, the timing circuit would, of course, be restarted whereby the sequence will be repeated. It will thus be noted that during the panic stop or incipient wheel skid condition, the engine is prevented from stalling and thereby the wheels are free to spin-up and regain speed as no resultant static engine load is imposed on the drive line or rear wheels during the cycle. Moreover, as indicated previously a source of vacuum is maintained for operation of the modulating valve 24 and all power accessories are retained operable during the skid control cycle. Further, a sufficient power source is provided in the form of either vacuum or hydraulic pressures for operation of the declutching actuator 46.

WHAT WE CLAIM IS:—

1. A system for automatically disengaging the clutch of a wheeled vehicle having fluid pressure actuated brakes and a manually operable transmission and clutch during the imminence of a wheel skid condition, the system comprising sensing means for detecting the imminence of wheel skid conditions and providing output signals in response thereto; and actuating means responsive to at least one of the output signals for disengaging the clutch, and cancelling means; including timing means for establishing a predetermined time interval following operation of the actuating means, for permitting the clutch to be reengaged after elapse of the time interval.

2. A system as claimed in claim 1, further comprising modulating valve means responsive to said output signals for cyclically relieving and reapplying the fluid pressure to the brakes.

3. A system as claimed in claim 1 or 2, wherein the actuating means includes latching means for maintaining the actuating means actuated for a time duration greater than that of each of the output signals, the timing means being arranged to restart the predetermined time interval upon a subsequent output signal whereby the actuating means can maintain the clutch disengaged over a plurality of the output signals.

4. A system as claimed in claim 3, wherein the cancelling means is operative after said predetermined time interval to cancel the latching means to permit the clutch to be re-engaged.

5. A system as claimed in claim 3 or 4, further including comparator means receiving said at least one output signal and responsive to the latching means for detecting a failure of the latching means to actuate in response to said at least one output signal.

6. A system as claimed in claim 3, 4 or 5, further including failure indicating means responsive to a failure of the latching means for providing an indication to the vehicle operator of such failure.

7. A system as claimed in any preceding claim, including control module means responsive to the sensing means for providing the output signals.

8. A system as claimed in any preceding claim, wherein the cancelling means is a timing circuit energized by at least one of said output signals and re-energizable by a subsequent signal.

9. A skid control system for a vehicle having fluid actuated brakes and a manually operated transmission and a clutch, the skid control system including a system for automatically disengaging the clutch as claimed in any preceding claim.

10. A system as claimed in claim 9, wherein the actuating means comprises an actuator member adapted to be operatively connected to the clutch; an electrically operated valve for actuating said actuator member; and a latching circuit rendered conductive by the output signal and connected to the electrically operated valve.

11. A vehicle clutch disengaging system constructed and arranged to operate substantially as herein described with reference to

and as illustrated in Figures 1 to 3 of the acompanying drawings.

12. A wheeled vehicle having fluid pressure actuated brakes, a manually operable transmission and clutch and a system according to any preceding claim.

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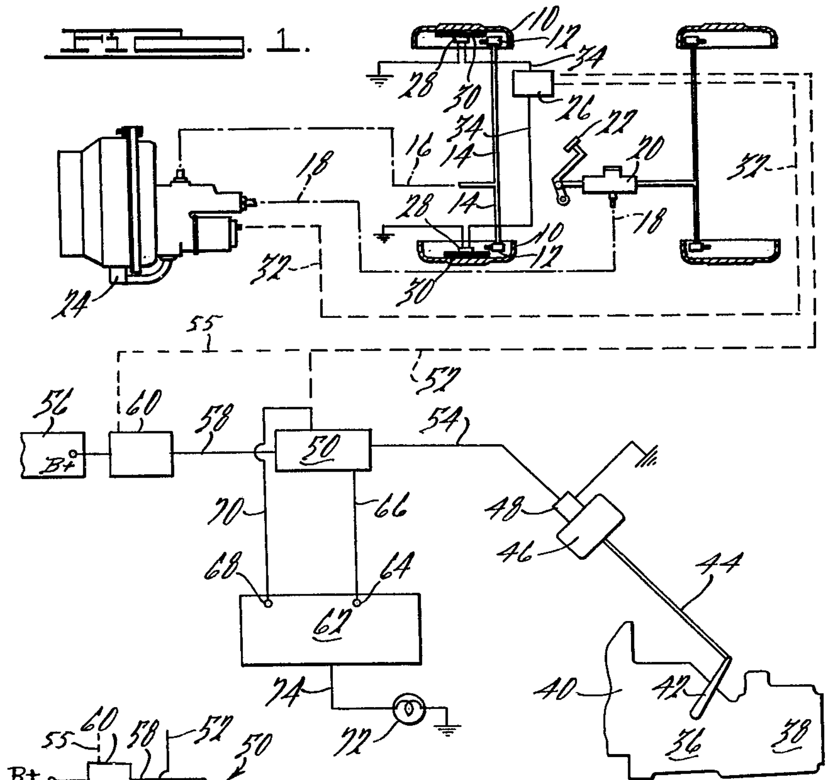
1405787 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale

FIG. 1.



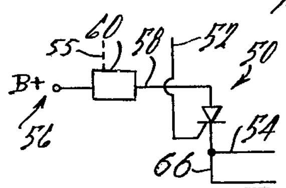


FIG. 2.

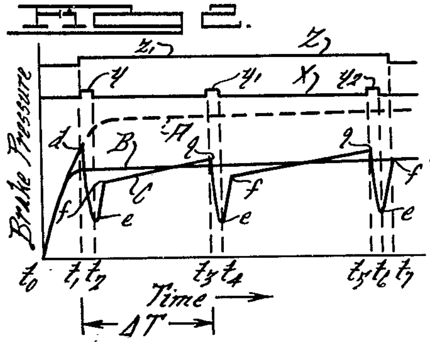


FIG. 3.